SECTION 5

Evaluation of Remedial Options

This section presents the evaluation performed for the remedial options considered. The evaluation was generally qualitative.

5.1 Evaluation Criteria

The objective of the remedial options is to successfully control and/or treat methane migrating from Landfill 26 so that the regulatory requirement of 5 percent methane is achieved at the compliance points (new probes adjacent to the property boundary).

The criteria considered for the evaluation of remedial options consist of:

- Expected effectiveness in achieving the remediation criterion.
- Qualitative risk
- Feasibility of potential remedial option
- Expected efficiency of the option
- Cost of remedial option

A list of uncertainties and data gaps was also developed for each remedial option evaluated.

Relative to protection of the existing landfill RCRA cap and final cover system, considerations that need to be addressed with any potential gas control measures implemented at Landfill 26 include:

- Maintaining a minimum of 2 percent slope on the landfill cover to prevent ponding of water on the cap
- Maintaining drainage away from the cover system to prevent ponding of water on the cap
- Maintaining the integrity of the RCRA cap by avoiding penetrations of the cover system
- Preventing damage to any of the existing environmental monitoring and control systems (e.g. groundwater monitoring network and drainage collection system)
- Preventing erosion of the final cover system soils
- Avoiding disturbance of contaminated areas within the buffer zone
- Minimizing restrictions to future recreational reuse
- Prohibiting structures on the landfill or within the buffer zone described in the Final Plan to minimize the risk for buildup of landfill gas in structures, utility vaults, utility trenches, or other foundations on the landfill property and beyond

The cost estimates developed for this study have been derived from the expected costs for major option components and primary expense categories including: design, construction, oversight, permits, operations and maintenance, and equipment replacement. The construction cost estimates are based on industry standard rates for the specific tasks associated with the remedial option. Design costs are estimated as a minimum of 20 percent of construction costs. Oversight cost includes construction documentation costs and a Resident Engineer on site for the duration of the project. The permit cost estimates are based on engineering experience and are a minimum of 5 percent of the construction costs. The continued landfill-gas monitoring costs are estimated based on information provided by the USACE. The resulting estimated costs for each remedial option are general order and magnitude, estimates. Actual costs based on final design decisions will differ. Costs assume the discount and inflation rates are both 8 percent.

5.2 Evaluation of Options

The following seven subsections present brief descriptions of the concept, function, and components of the mitigation options evaluated. Technical evaluations, uncertainties/data gaps, costs, and advantages/disadvantages are also presented for each remedial option. Section 5.3 presents a table (Table 5-1, included at the end of this section) that summarizes the evaluation of each option.

Options 2 through 6 were developed to include Option 1- Continue Landfill Gas Probe Monitoring. Because Options 2 through 6 include Option 1, the evaluation presented in Option 1 is not repeated for each other option. Although Options 2 through 6 include Option 1, their evaluation focuses on the differing aspects of each option.

5.2.1 Option 1: Continue Landfill Gas Probe Monitoring

This section briefly summarizes the continuance of landfill gas probe monitoring without additional mitigation measures. This option would include updates to the monitoring network and program, as needed

5.2.1.1 Brief Description

The concept, function, and components are briefly described below.

Concept

The concept for this option is to continue annual landfill gas probe monitoring of probes (GMP-1 to GMP-23) in accordance with *Final Work Plan for Landfill Monitoring Program* as amended (ITSI, 1999; ITSI, 2000a). Additionally monthly sampling of GMP-5 through GMP-13 and the 15 new probes will be conducted for one year beginning April 2001. Following the one year of monthly sampling, quarterly monitoring of GMP-5 through GMP-13 and the 15 additional probes to be installed in 2001 will be performed. Probes that have occasional methane detections above 5 percent year will continue to be sampled monthly.

For the purposes of this study, monitoring is assumed to be required for a period of 30 years.

Function

This option addresses ***Release, Transport, and Receptor Protection***: monitoring will be used to verify the presence of landfill gas in the buffer zone, as well as to provide data over time on release migration and degradation. The new probes installed closer to the property line will monitor the presence of methane closest to the receptors.

Components

The following components will be used to continue monitoring at Landfill 26:

- Monitor, inspect, and sample (annually) the existing 23 probes, including the probes in the buffer zone along the eastern and southern perimeter of the landfill and the 15 new probes that will be installed in 2001 (see Figure 2-1)
- Analyze annually collected samples for benzene, methylene chloride, carbon dioxide, methane, nitrogen, and oxygen in accordance with the Final Plan
- For one year, monitor monthly the 15 probes to be installed in 2001 in the buffer zone, plus the GMP-5 through GMP-13; analyze the samples for methane
- In subsequent years, monitor quarterly, maintaining a monthly schedule for probes that had occasional detections of methane above 5 percent
- Measure static water level in probes at time of monitoring
- Measure initial and final static pressure in the probes at time of monitoring

5.2.1.2 Technical Evaluation

Qualitative Risk

This option does not reduce the risk of methane migrating from the landfill, but it does monitor for its presence in the buffer zone.

Feasibility of Potential Remedial Option

This option is feasible and is currently being implemented. This option presents no real technical challenges to implement. The new GMP probes should be screened above the seasonal high groundwater elevation.

Expected Efficiency of the Option

This option will have zero efficiency in remediating current and future methane migration. This option is an efficient way to monitor for the presence of and movement of gas migration in the buffer zone.

5.2.1.3 Uncertainties/Data Gaps

Regarding probe installation and the sampling program, the following concerns exist:

- Variations in sampling techniques may influence sample results and reliability. Comparisons of historical data to currently available data and/or data that will be generated in the future should consider possible variations in results from equipment and sampling techniques.
- Monitoring frequency currently does not fully characterize seasonal variations that may be observable with a lack of data, primarily during the winter and spring months, or the months between quarterly sampling events.

- Groundwater elevation fluctuations should be considered when reviewing future gas probe monitoring data and probe screen interval designs.
- As described in Section 3, dissolved methane concentrations in groundwater do not correlate well with observed methane gas measurements in corresponding wells. Because this option only monitors soil gas, it is not likely to monitor dissolved methane in groundwater. Ongoing studies by USACE will determine whether dissolved methane in groundwater is an issue.

5.2.1.4 Cost

Estimated costs for this option are approximately:

- 30-year annualized cost $110,000 per year
- Net present value $1.2 million total cost

This estimate was calculated as described in Section 5.1.

5.2.1.5 Advantages and Disadvantages

Advantages

The advantages of this option include:

- This option is a relatively low-cost option.
- Monitoring will provide additional information on seasonal trends and vadose zone distribution of methane gas in the buffer zone.

Disadvantages

The disadvantages of this option include:

- This option does not mitigate migration methane in soil gas or dissolved methane in the groundwater.
- Implementing this option will not remediate the source of methane.
- Implementing this option does not prevent transport of methane beyond the buffer zone.

5.2.2 Option 2: Monitoring Combined with Installation of Passive Cap-Venting System

This section briefly discusses the concept of a passive cap-venting system.

5.2.2.1 Brief Description

Concept

The concept for this option is to continue landfill gas probe monitoring, as described for Option 1, and to provide for passive ventilation of landfill gas from beneath the RCRA cap.

Function

This option addresses ***Release, Transport, and Receptor Protection*** (as described for Option 1). This option is intended to reduce the amount of methane generated and provide an alternate discharge point, within the boundaries of the landfill.

Components

The following components could be used to implement a passive cap-venting system for Landfill 26:

- Install vents through the RCRA cap along the perimeter of the cap between GMP-5 and GMP-13 (see Figure 5-1) in locations sufficient to allow one of the following options:
  - Landfill gas to flow out through the cap rather than beneath the lateral limits of the cap
  - Oxygen to enter the waste zone, thereby encouraging aerobic waste degradation and bypass of the generation of methane

Sufficient data is not available to determine the specific number of vents required nor the location of the vents that would be required for the placement of vents or their design.

5.2.2.2 Technical Evaluation

Qualitative Risk

This option reduces the risk of methane migrating from the landfill and monitors for its presence in the buffer zone. Although vents provide an escape pathway for landfill gas from the RCRA cap, ensuring that the venting system can capture all escaping gas is not feasible and some lateral gas migration could still be anticipated.

Feasibility of Potential Remedial Option

Penetrating the RCRA cap and installing a passive venting system is not likely to receive regulatory approval, at least without considerable time and cost to negotiate, design, and install the system.

Expected Efficiency of the Option

This option could be expected to be moderately efficient in eliminating the gas pressure driving lateral migration. It will have zero efficiency in remediating the existing methane in the buffer zone.

5.2.2.3 Uncertainties/Data Gaps

Because data are not available on localized generation rates, and pressure data to date are seasonally incomplete, the appropriate spacing and locations of exhalation vents cannot be reliably established, and design and installation of this option would have to proceed only after additional data are collected from within the landfill. The long-term reliability of cap penetrations is not known.

If the vents were to be open to atmosphere (flow into and out of the landfill according to atmospheric conditions), the system would need to avoid being installed where (or if) there is a potential for subsurface combustion to occur. Several factors suggest this to be unlikely, but it would need to be investigated prior to design:

- Age of the landfill, suggesting an advanced state of waste degradation
- Uncapped, aerobic state of the landfill until capping in 1994-95 (with no reported incidents of subsurface combustion while aerobic)

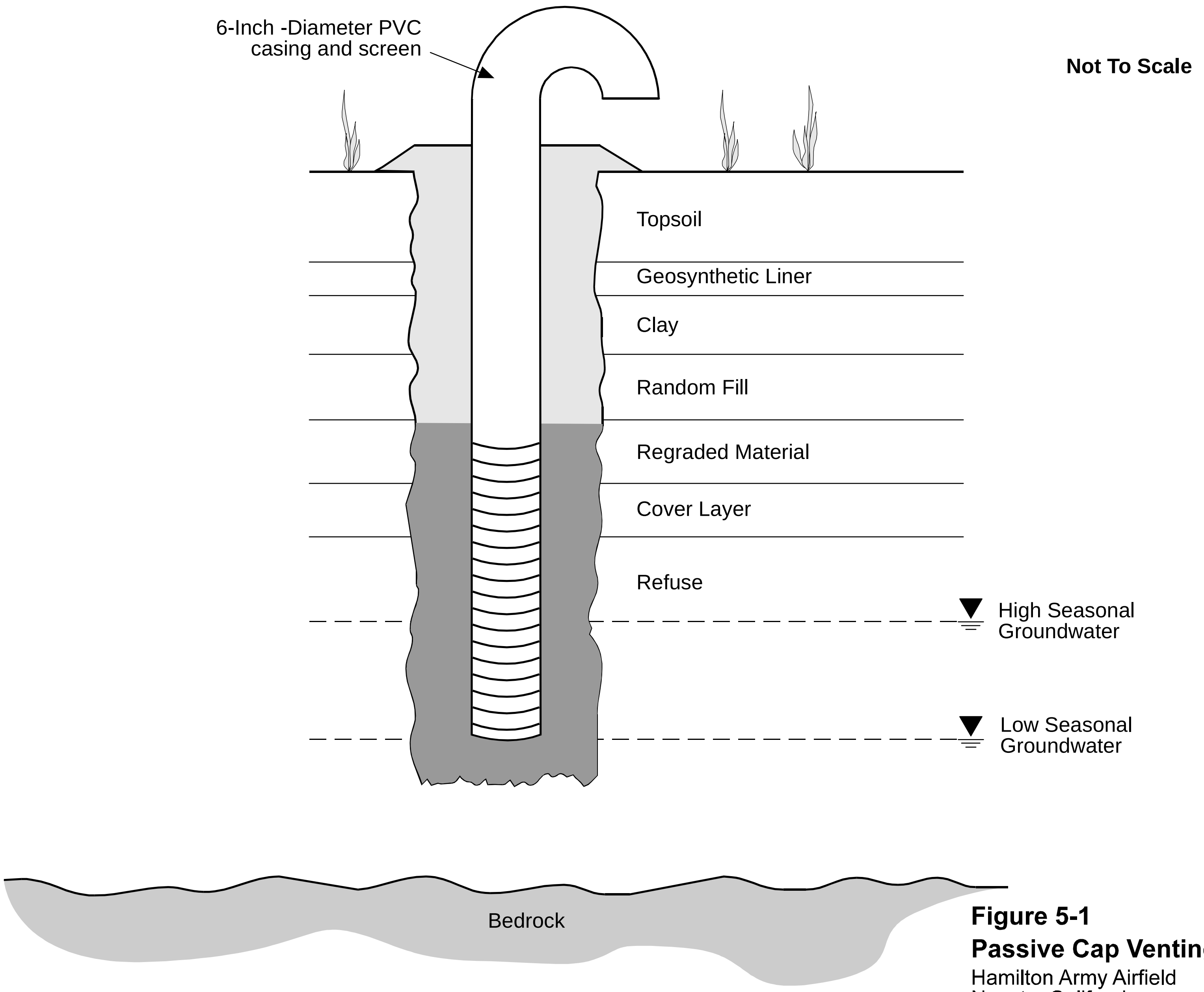


Figure 5-1
Passive Cap Venting System
Hamilton Army Airfield
Novato, California

CH2MHILL

- Relatively unaffected groundwater temperature, indicating a small amount of exothermic degradation, relative to the total waste volume
- Low apparent gas generation rate, suggesting a limited volume or concentration of decomposing matter

5.2.2.4 Cost

Estimated costs for this option are approximately:

- Total 30-year annualized cost $140,000 per year ($110,000 of which is the Option 1, monitoring, component)
- 30-year annualized cost $30,000 per year for the Option 2 specific components
- Net present value $1.6 million total cost ($1.2 million of which is the Option 1, monitoring, component)

This estimate was calculated as described in Section 5.1.

5.2.2.5 Advantages and Disadvantages

Advantages

The advantages of this option include:

- Mitigates methane generation at the source
- Vents serve as additional monitoring points throughout the landfill for delineating generation areas
- Relieves gas pressure within the landfill, reducing the potential for lateral migration of methane gas
- Monitoring will provide additional information on seasonal trends and vadose zone distribution of methane gas in the buffer zone

Disadvantages

The disadvantages of this option include:

- May jeopardize hydraulic integrity of landfill cap
- May be difficult to gain regulatory approval for cap penetrations
- Should not be designed until more data are collected on the generation of methane beneath the RCRA cap
- Would likely take considerable time to negotiate regulatory approval of, to prepare design for, and to construct the system
- Does not address migration of dissolved methane in groundwater, if dissolved methane is determined to be an issue
- May not solve the lateral migration problems and will not remediate existing methane in buffer zone

- Could render the landfill top deck unsuitable for recreational reuse, unless extensive trenching and subsurface headers were installed
- Bay Area Air Quality Management District (BAAQMD) permit likely required

5.2.3 Option 3: Monitoring Combined with Installation of a Passive Buffer Zone Venting Trench

This section briefly describes a passive buffer zone venting trench system.

5.2.3.1 Brief Description

Concept

The concept for this option is to provide for passive ventilation of landfill gas within the buffer zone.

Function

This option addresses ***Release, Transport, and Receptor Protection*** (as described for Option 1). In addition, this option seeks to intercept methane near the point of release from the landfill boundary.

Components

The following components would be used to implement a passive buffer zone venting trench system for Landfill 26:

- Install a gravel-backfilled trench to slightly below the water table in the buffer zone along the edge of the landfill cap (see Figure 5-2), and install a series of risers connected to a screened horizontal pipe above the water table to:
  - Allow landfill gas exiting the landfill to be passively vented to atmosphere
  - Create an aerobic soil media within the trench backfill that would foster methane degradation prior to venting
  - Allow partitioning of methane in groundwater to the vapor phase, to passively reduce methane in groundwater beyond the trench, if dissolved methane is determined to be an issue

Figure 5-3 shows a conceptual view of possible locations of the passive buffer zone venting trench system. Additional information regarding the location and seasonal nature of methane in the buffer zone will be required prior to establishing the location and design details for the passive venting trench. Multiple trenches may be required depending upon the outcome of the current USACE studies.

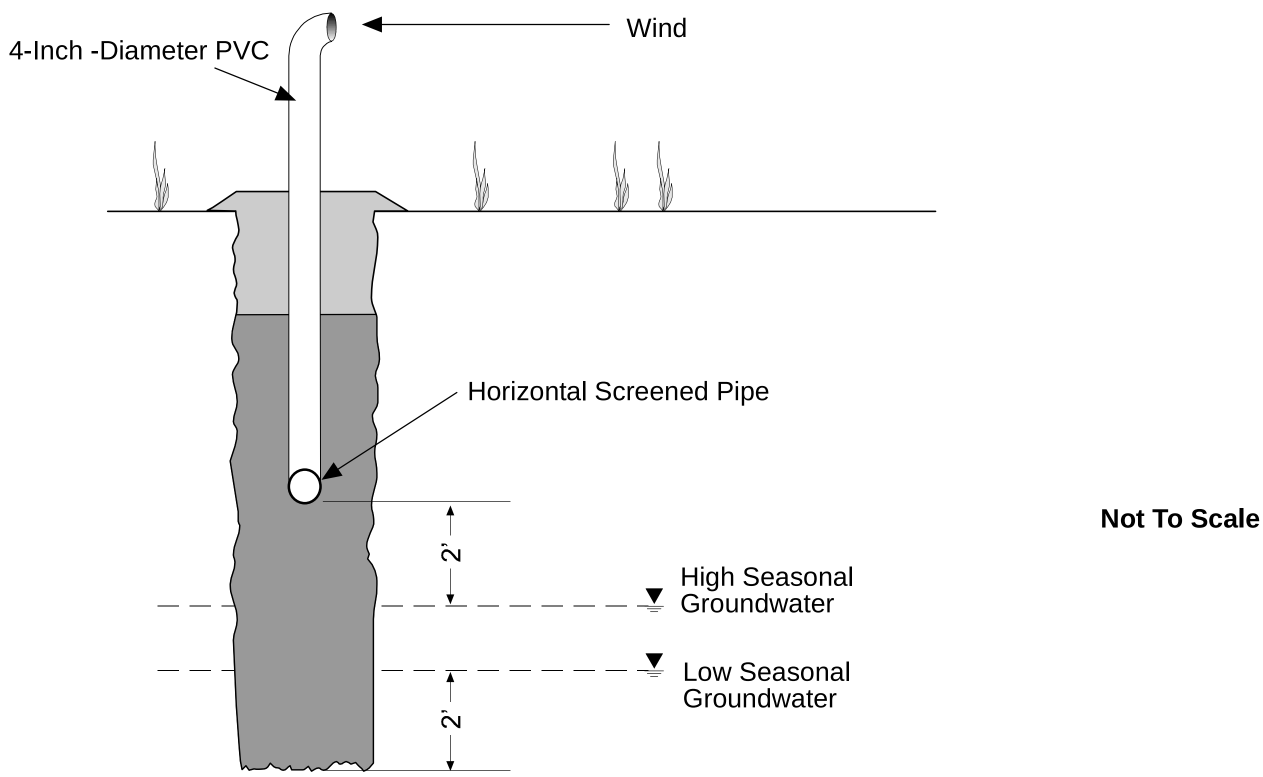
5.2.3.2 Technical Evaluation

Qualitative Risk

This option reduces the risk of methane migrating from the landfill through the buffer zone in the areas treated, and it monitors for the presence of methane in the buffer zone.

Feasibility of Potential Remedial Option

The passive trench portion of this option is feasible to design and construct. Additional data will be needed to design the placement and design details of this option.



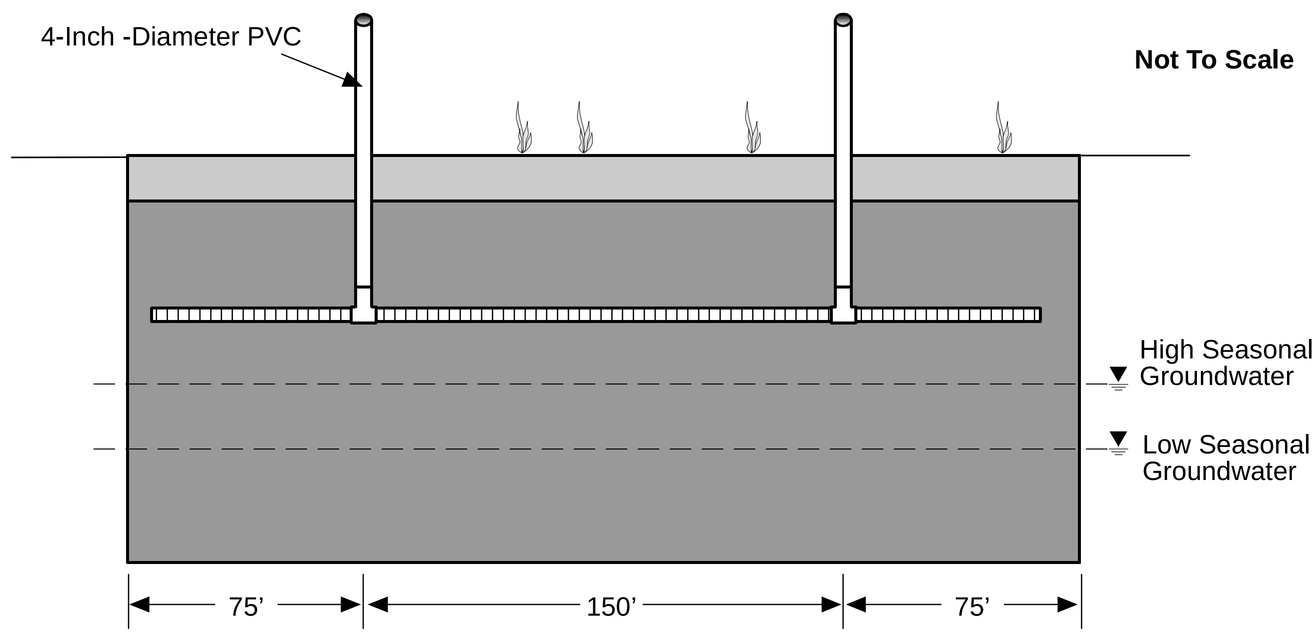


Figure 5-2
Passive Buffer Zone Venting Trench
Hamilton Army Airfield
Novato, California

CH2MHILL

163181.12.MS passive_buffer.FH8 3-26-01 dash

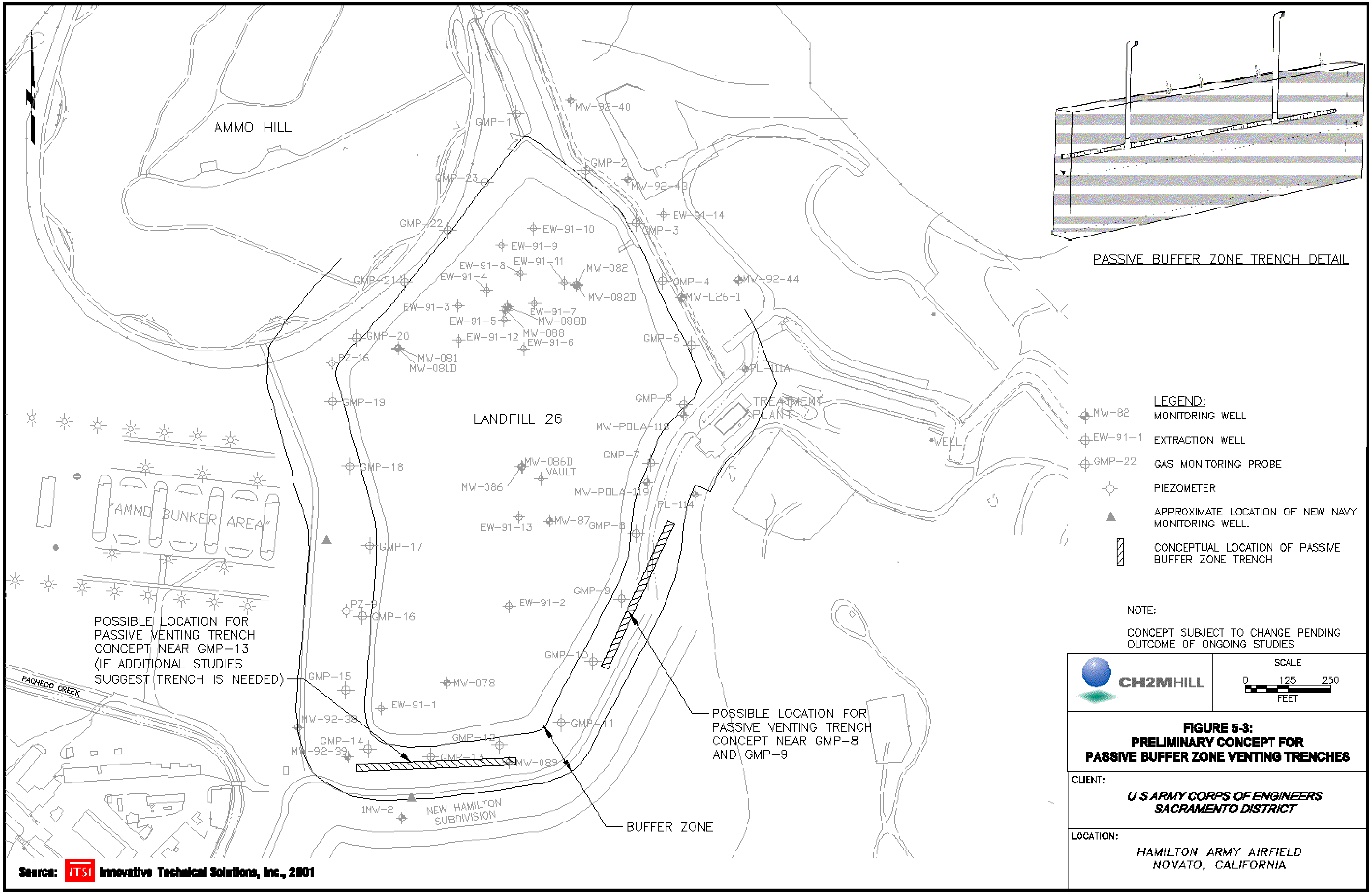


FIGURE 5-3: PRELIMINARY CONCEPT FOR PASSIVE BUFFER ZONE VENTING TRENCHES

Expected Efficiency of the Option

This option could be expected to be efficient in allowing intercepted methane a preferential pathway to vent (and not migrate). This option is not expected of be efficient in introducing oxygen to the subsurface surrounding the trench to remediate existing methane. However, this option offers the advantage that it could be readily adapted to an active extraction mode if passive venting proves ineffective in remediating methane concentrations.

5.2.3.3 Uncertainties/Data Gaps

The precise areas where it would be most cost effective to install the trench are not defined by the currently available data. The additional GMPs currently being installed by USACE may provide additional information.

The degree to which this option will passively aerate groundwater is not known, and has been evaluated to have a low probable effectiveness , if dissolved methane in groundwater is determined to be an issue.

5.2.3.4 Cost

Estimated costs for this option are approximately:

- Total 30-year annualized cost $130,000 per year ($110,000 of which is the Option 1, monitoring, component)
- 30-year annualized cost $20,000 per year for the Option 3 specific components
- Net present value $1.4 million total cost ($1.2 million of which is the Option 1, monitoring, component).

This estimate was calculated as described in Section 5.1.

5.2.3.5 Advantages and Disadvantages

Advantages

The advantages to this option include:

- Does not disturb the landfill cap
- Is well suited to precise placement at the location of preferential pathways once data are available to determine the location of preferential pathways
- Provides atmospheric barrier to intercept and reduce methane gas in the buffer zone between source and potential receptors
- Can be adapted to provide active extraction
- Addresses methane soil gas already in the buffer zone
- Modular / expandable system can expand as new data become available
- Passive system has little to no maintenance costs, no fuel necessary
- May passively treat dissolved methane in groundwater, if dissolved methane requires treatment

- Promotes natural degradation of methane

Disadvantages

The disadvantages to this option include:

- Not adaptable to significant groundwater elevation changes
- Does not directly treat dissolved methane in groundwater, if dissolved methane requires treatment
- Potential additional considerations if construction is required in subsurface near former Quarter Master's Yard
- BAAQMD permit likely required

5.2.4 Option 4: Monitoring Combined with Installation of an Active Buffer Zone Venting Trench

This section briefly describes an active buffer zone venting trench.

5.2.4.1 Brief Description

Concept

The concept for this option is to provide for active ventilation of a trench to treat landfill gas and/or methane-containing groundwater (if dissolved methane is determined to be an issue) in the buffer zone adjacent to the lateral limits of the RCRA cap.

Function

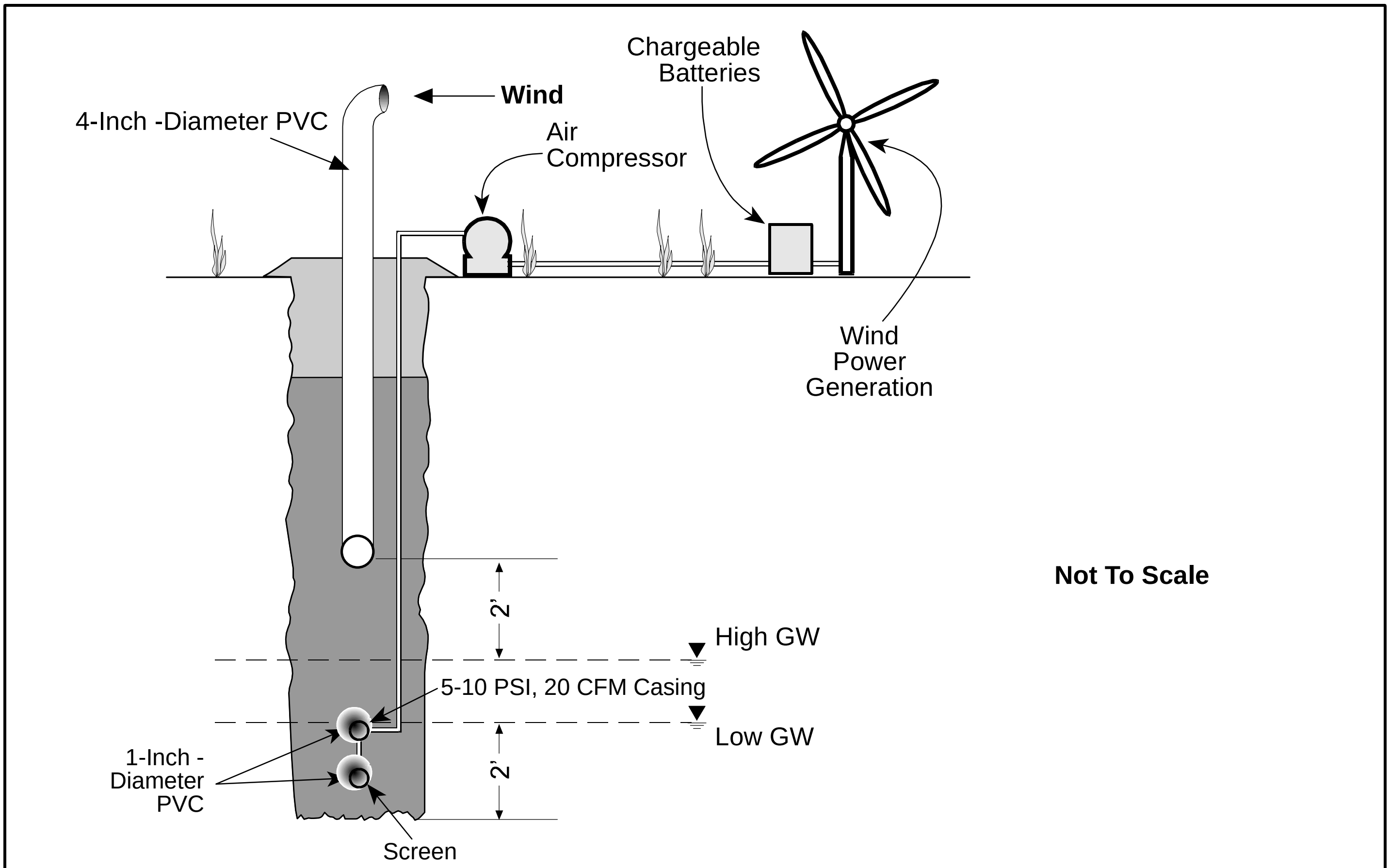
This option addresses ***Release, Transport, and Receptor Protection*** (as described in Option 1). This option also addresses Release by seeking to intercept methane at the point of release from the landfill.

Components

The following components would be used to implement an active buffer zone venting trench for Landfill 26:

- Install a trench in the buffer zone along the edge of the landfill cap into the water table (see Figure 5-4), with a sparging screen below the water table using small blower or compressor, powered by a marine windmill generator battery assembly to:
  - Provide oxygen to the groundwater by sparging atmosphere into the submerged portion of the trench; volatilize methane from groundwater; and raise the dissolved oxygen in the groundwater (for downgradient effects)
  - To supply oxygen to the trench and to the surrounding soil above the water table
- Install a screened horizontal pipe above the water table, to passively aerate the trench (see Option 3)

Figure 5-5 shows the conceptual location of the trench.



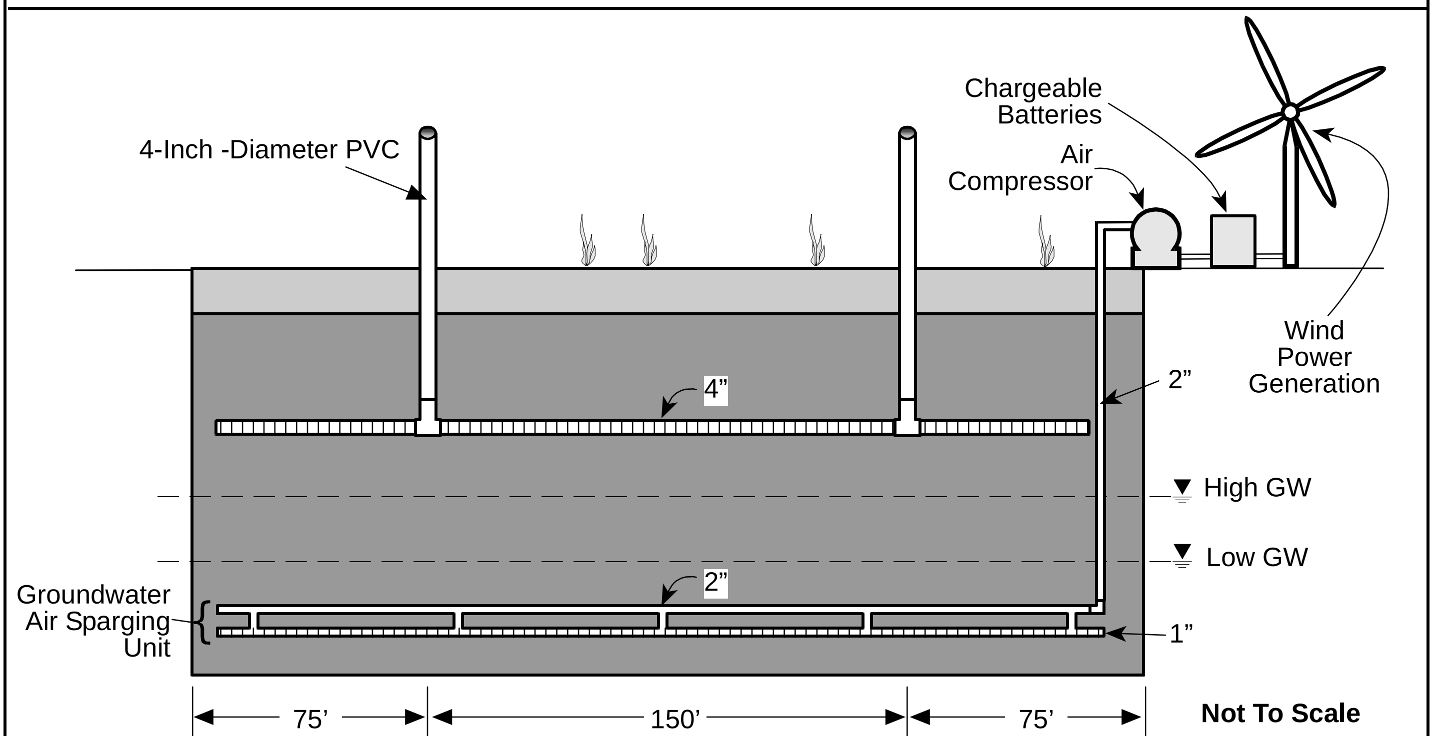
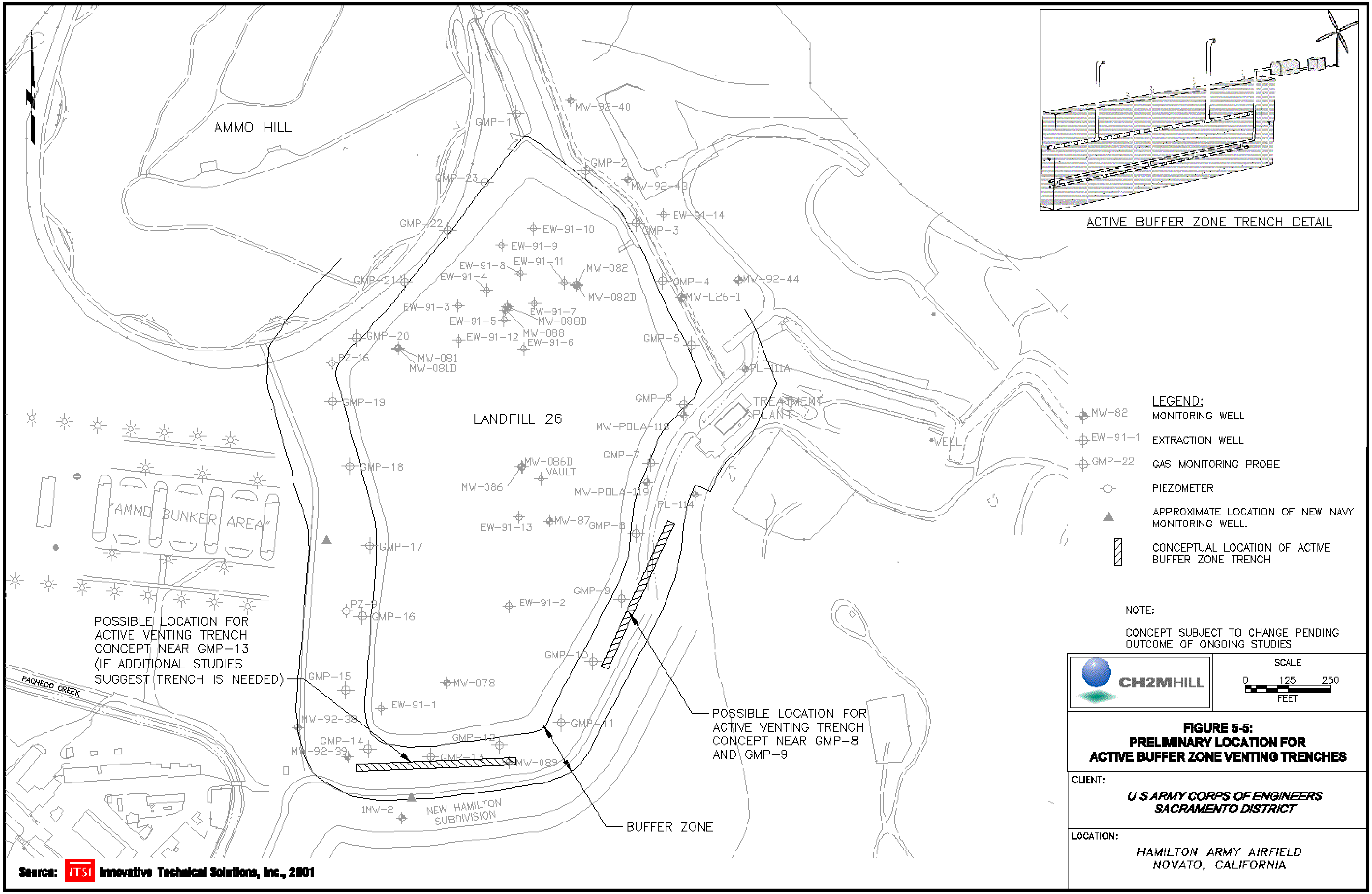


Figure 5-4
Active Buffer Zone Venting Trench
Hamilton Army Airfield
Novato, California


ACTIVE BUFFER ZONE TRENCH DETAIL
AMMO HILL
LANDFILL 26
"AMMO BUNKER AREA"
TREATMENT PLANT
WELL
PACHECO CREEK
NEW HAMILTON SUBDIVISION
GMP-1
GMP-2
GMP-3
GMP-4
GMP-5
GMP-6
GMP-7
GMP-8
GMP-9
GMP-10
GMP-11
GMP-12
GMP-13
GMP-14
GMP-15
GMP-16
GMP-17
GMP-18
GMP-19
GMP-20
GMP-21
GMP-22
GMP-23
MW-92-40
MW-92-43
MW-92-44
MW-92-38
MW-92-39
EW-91-14
EW-91-10
EW-91-9
EW-91-8
EW-91-11
EW-91-4
EW-91-3
EW-91-5
EW-91-7
EW-91-12
EW-91-6
EW-91-13
EW-91-2
EW-91-1
MW-082
MW-082D
MW-088D
MW-088
MW-081
MW-081D
MW-L26-1
PL-111A
PL-114
MW-POLA-118
MW-POLA-119
MW-086D
VAULT
MW-086
MW-87
MW-078
MW-089
PZ-16
PZ-9
1MW-2
POSSIBLE LOCATION FOR ACTIVE VENTING TRENCH CONCEPT NEAR GMP-13 (IF ADDITIONAL STUDIES SUGGEST TRENCH IS NEEDED)
POSSIBLE LOCATION FOR ACTIVE VENTING TRENCH CONCEPT NEAR GMP-8 AND GMP-9
BUFFER ZONE
LEGEND:
MW-82 MONITORING WELL
EW-91-1 EXTRACTION WELL
GMP-22 GAS MONITORING PROBE
PIEZOMETER
APPROXIMATE LOCATION OF NEW NAVY MONITORING WELL.
CONCEPTUAL LOCATION OF ACTIVE BUFFER ZONE TRENCH
NOTE:
CONCEPT SUBJECT TO CHANGE PENDING OUTCOME OF ONGOING STUDIES
CH2MHILL
SCALE
0 125 250
FEET
FIGURE 5-5:
PRELIMINARY LOCATION FOR ACTIVE BUFFER ZONE VENTING TRENCHES
CLIENT:
U S ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT
LOCATION:
HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA
Source: ITSI Innovative Technical Solutions, Inc., 2001

5.2.4.2 Technical Evaluation

Qualitative Risk

This option reduces the risk of methane migrating from the landfill through the buffer zone in the areas treated and it monitors for the presence of methane in the buffer zone. Active components will require full-time maintenance.

Feasibility of Potential Remedial Option

The active trench portion of this option is feasible to design and construct, but will require additional information to locate it in order to perform optimally in intercepting migrating methane. Additional information provided by the installation of new GMPs in 2001 may assist in locating these trenches.

Expected Efficiency of the Option

This option could be expected to be efficient in allowing intercepted methane a preferential pathway to vent (and not migrate) and efficient in introducing oxygen to the subsurface to remediate existing methane, both in the groundwater and in the vadose zone.

5.2.4.3 Uncertainties/Data Gaps

The groundwater treatment option would require knowledge of the locations where methane is currently present in groundwater, as well as where it could be appear in the future.

This active system will require the operation of a relatively small blower. The reliability of a wind-driven generator and compressor is warranted for 5 years, but future costs are not known.

5.2.4.4 Cost

Estimated costs for this option are approximately:

- Total 30-year annualized cost $140,000 per year ($110,000 of which is the Option 1, monitoring, component)
- 30-year annualized cost $30,000 per year for the Option 4 specific components
- Net present value $1.6 million total cost ($1.2 million of which is the Option 1, monitoring, component)

This estimate was calculated as described in Section 5.1.

5.2.4.5 Advantages and Disadvantages

Advantages

The advantages to this option include:

- Landfill cap remains undisturbed
- Addresses methane in soil gas
- Addresses dissolved methane in groundwater, if dissolved methane in groundwater is determined to be an issue

- Serves as a mitigation screen between source and potential receptors
- In situ technology requires no flare

Disadvantages

Disadvantages of this option include:

- Not adaptable to significant groundwater elevation changes
- Significant operational monitoring and maintenance costs
- Above ground components of system may be subject to vandalism
- Air supply may be needed
- Significant above ground components may restrict future land use options

5.2.5 Option 5: Monitoring Combined with Installation of Utility Protection System

This section briefly discusses a utility protection system.

5.2.5.1 Brief Description

Concept

The concept for this option is to retrofit existing utilities and new construction to include backfill plugs/dams, relief/aeration vents, and conduit seals or vents in subsurface utilities within the buffer zone of the landfill.

Function

This option addresses ***Transport, Release, and Receptor Protection*** (as described in Option 1). It also addresses ***Receptor Protection***, based on the premise that the risks associated with methane could occur in identifiable subsurface utility structures.

Components

The following components will be used to continue monitoring, combined with a utility protection system for Landfill 26:

- Retrofit existing utilities and new construction to include backfill plugs/dams, relief/aeration vents, and conduit seals or vents in subsurface utilities within the buffer zone (see Figure 5-6)

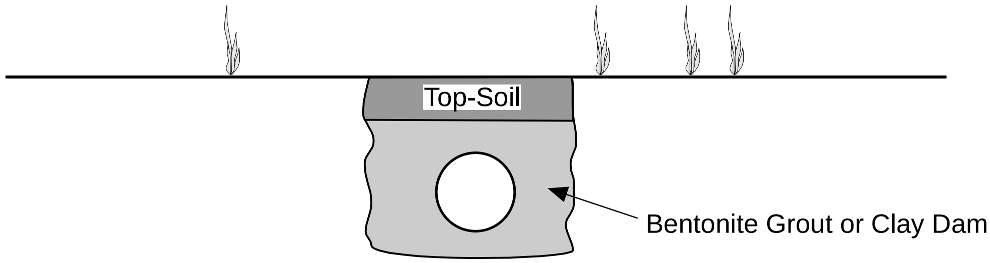
5.2.5.2 Technical Evaluation

Qualitative Risk

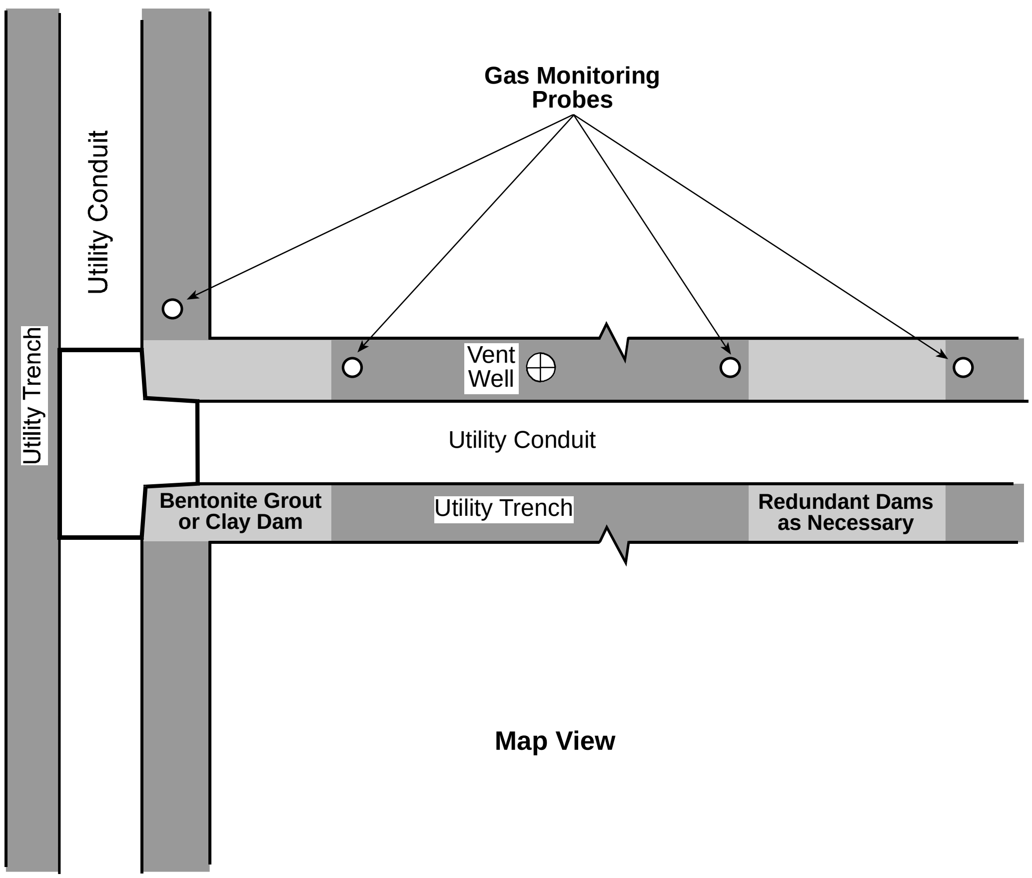
This option reduces the risk of methane migrating from the landfill into an adjacent utility trench backfill zone in the areas where the option is constructed and monitors for its presence in the buffer zone. This option does not reduce the overall risk of methane migrating into and through the buffer zone.

Feasibility of Potential Remedial Option

The utility protective system portion of this option is feasible to design, but may present construction difficulties for the existing utility trenches.



Cross Section



Map View

Not To Scale

Figure 5-6
Utility Trench Protection System
Hamilton Army Airfield
Novato, California

CH2MHILL

Expected Efficiency of the Option

This option could be expected to be efficient in blocking gas migration and providing venting in the utility trenches within the buffer zone of the landfill. This option has no efficiency in blocking migration through the buffer zone.

5.2.5.3 Uncertainties/Data Gaps

The current data and history of vapor monitoring do not allow a clear understanding as to the appropriate distance from the landfill at which such measures should be taken. Because the methane is being addressed within the buffer zone, such measures might not encompass all possible routes of methane migration or exposure, leading to some uncertainty.

Uncertainties in the effectiveness of this option exist because there may be utility trenches existing at this time that have not been adequately documented, future utility trenches may not use these measures, and not all routes may be addressed. Also, some of the protection measures can be difficult to retrofit to existing utilities.

5.2.5.4 Cost

Estimated costs for this option are approximately:

- Total 30-year annualized cost $120,000 per year ($110,000 of which is the Option 1, monitoring, component)
- 30-year annualized cost $10,000 per year for the Option 5 specific components
- Net present value $1.3 million total cost ($1.2 million of which is the Option 1, monitoring, component)

This estimate was calculated as described in Section 5.1.

5.2.5.5 Advantages and Disadvantages

Advantages

The advantages to this option include:

- Easy to monitor
- Focused on primary route of migration and receptors
- Directly addresses the trench routes
- Certainty of application
- Certainty of location
- Redundant “dams” increase effectiveness
- Reduces risk of explosive levels of methane at receptors

Disadvantages

The disadvantages of this option include:

- Will not remediate methane in the buffer zone
- No control over what homeowners do in their yards (sprinkler boxes, sheds, etc.)
- Does not address gas migration in regions other than major utility trenches
- May miss unmapped / unknown subsurface trenches (if present)

5.2.6 Option 6: Monitoring Combined with Activation of the Existing Groundwater Pump-and-Treat System

This section briefly discusses activation of the existing groundwater pump-and-treat system.

5.2.6.1 Brief Description

Concept

The concept for this option to reactivate the existing groundwater treatment system.

Function

This option addresses ***Release, Transport, and Receptor Protection*** (as described in Option 1 in terms of gas). The ability of the groundwater treatment component to address ***Release, Transport, Receptor Protection***, and / or ***Generation/Accumulation*** is not certain.

Components

The following components would be used to reactivate the existing groundwater pump-and-treat system for Landfill 26:

- Reactivate the groundwater pump-and-treat system
- Operate, maintain and monitor the treatment system

5.2.6.2 Technical Evaluation

Qualitative Risk

This will not likely reduce the risk of methane gas migrating from the landfill into the buffer zone.

Feasibility of Potential Remedial Option

Reactivation of the groundwater treatment plant under this option may not be feasible, given the likely time and significant costs involved to reactivate the treatment plant.

Expected Efficiency of the Option

This plant was not designed to treat dissolved methane. The efficiency of the plant in treating methane in the extracted groundwater is not known. The plant will only treat groundwater, so will have zero efficiency in blocking gas migration through the buffer zone.

5.2.6.3 Uncertainties/Data Gaps

The effectiveness of the existing pumping network in capturing the groundwater containing dissolved methane is indirect but unknown. Within the landfill, a lower water table could have an effect on the rate of methane generation. It is also unknown what effect the operation of the system would have on the water levels at the perimeter of the cap, which could alter the manner in which landfill gas accumulates and the location where it releases to the adjacent subsurface.

5.2.6.4 Cost

Estimated costs for this option are approximately:

- Total 30-year annualized cost $280,000 per year ($110,000 of which is the Option 1, monitoring, component)

- 30-year annualized cost $170,000 per year for the Option 6 specific components
- Net present value $3.1 million total cost ($1.2 million of which is the Option 1, monitoring, component)

This estimate was calculated as described in Section 5.1.

5.2.6.5 Advantages and Disadvantages

Advantage

The advantage to this option includes:

- Plant and wells are present

Disadvantages

The disadvantages to this option include:

- Plant will require significant work to reactivate
- Costs associated with operation, maintenance and long-term monitoring are significant
- Will not treat methane in soil gas within the buffer zone
- Will not prevent methane migration in soil
- Will not remediate methane in groundwater
- NPDES permit update likely required

5.2.7 Option 7: Monitoring Combined with an Active Extraction System with Pre-established System Shutdown Criteria

This section briefly discusses an active gas extraction system with pre-established system shutdown criteria.

5.2.7.1 Brief Description

Concept

The concept for Option 7 installation and operation of an active landfill gas collection system until a specific criterion is met.

Function

This option addresses ***Transport, Release, and Receptor Protection*** (as described in Option 1). It will also address ***Generation/Accumulation***.

Components

The following components will be used to continue monitoring, combined with an active extraction system for Landfill 26:

- Install a landfill gas extraction system, with wells penetrating through the RCRA cap and a new blower-flare assembly, presumably without energy recovery

5.2.7.2 Technical Evaluation

Qualitative Risk

This option reduces the risk of methane migrating from the landfill. Although the extraction system will draw landfill gas from beneath the RCRA cap, ensuring that the extraction system can capture all escaping gas is not feasible and some lateral gas migration could still be anticipated.

Feasibility of Potential Remedial Option

The regulatory feasibility of the extraction system involves penetrating the RCRA cap and installing an extraction system, and is not likely, at least without considerable time and cost to negotiate, design, and install the system. Direct discharge to air without flaring may require a regulatory permit.

Expected Efficiency of the Option

This option could be expected to be efficient in eliminating the gas pressure that is driving lateral migration. It will probably have zero efficiency in remediating the existing methane in the buffer zone.

5.2.7.3 Uncertainties/Data Gaps

The actual rate and location of methane generation within the landfill is undetermined, and unless extensive in-landfill monitoring is performed, this could lead to over-design in terms of wells or system flow. Installing wells through the RCRA cap is likely to have low regulatory approval. Because of the age of the landfill and its constituents, the rate of landfill gas generation is likely to be far less than is needed to fuel a blower/flare system, and would probably require special engineering and supplemental fuel. The duration of system operation is also unknown, as is the need for, or frequency of, cycled or seasonal operation.

5.2.7.4 Cost

Estimated costs for this option are approximately:

- Total 30-year annualized cost $200,000 per year ($110,000 of which is the Option 1, monitoring, component)
- 30-year annualized cost $90,000 per year for the Option 7 specific components
- Net present value $2.2 million total cost ($1.2 million of which is the Option 1, monitoring, component)

This estimate was calculated as described in Section 5.1.

5.2.7.5 Advantages and Disadvantages

Advantages

The advantages of this option include:

- Addresses methane at the source
- High certainty of remediation
- Conventional approach

Disadvantages

The disadvantages of this option include:

- May require flare and associated maintenance and fuel—atmospheric discharge without flaring may require regulatory permit

- Does not treat groundwater
- Requires multiple cap penetrations
- Impairs future top deck recreational reuse
- Does not address methane in the buffer zone
- BAAQMD permit likely required

5.3 Evaluation Summary

Table 5-1 summarizes the evaluation of each option, using the criteria presented in Section 5.1. Each option is also summarized below.

Option 1 (Continue Landfill Gas Monitoring) was evaluated to be a comparatively low cost option and feasible to implement. This option is not intended to remediate methane in the buffer zone or the landfill. This option would provide for one year of monthly monitoring of soil gas concentrations around the south-southeastern perimeter of the buffer zone beginning April 2001. In subsequent years probes would be monitored quarterly maintaining the monthly monitoring frequency for probes that continue to occasionally detect methane above 5 percent.

Option 2 (Monitoring Combined with Installation of Passive Cap-Venting System) was evaluated to be a moderately priced option intended to focus on alleviating pressure in the landfill and potentially arresting the lateral migration of methane in the south and southeast areas of Landfill 26. This option would be potentially difficult to implement due to the need to penetrate the RCRA cap in several locations. This option is not expected to be effective in remediating methane that already exists in the buffer zone of the landfill. Additional information would be required to provide the technical basis for the location, number, and construction details for the vents.

Option 3 (Monitoring Combined with Installation of Passive Buffer Zone Venting Trench) was evaluated to be a comparatively low priced option and feasible to implement although additional data would be needed to provide the technical basis for the location number and construction details of the trench. This option is not intended to have an effect on the production of methane within the landfill. This option is expected to be effective in remediating soil gas methane in the buffer zone of the landfill. This option would not actively mitigate dissolved methane in groundwater, if methane in groundwater needs to be treated. However, it may passively effect concentrations of dissolved methane in groundwater. There is also the potential for vandalism of visible and accessible components of the system.

Option 4 (Monitoring Combined with Installation of an Active Buffer Zone Venting Trench) was evaluated to be a comparatively moderately priced option and feasible to implement although additional data will be needed to provide the technical basis for the location number and construction details of the trench. This option is not intended to have an effect on production of methane within the landfill. This option is expected to be effective in remediating soil gas methane in the buffer zone. This option is expected to be effective in remediating dissolved methane in groundwater within the buffer zone of the landfill, if

TABLE 5-1
Summary of Evaluation of Options
Hamilton Army Airfield Landfill 26 Methane Migration Remedial Options

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Description of Option	**Continue Landfill Gas Probe Monitoring:** Continue annual landfill gas probe monitoring of GMP-1 to GMP-23, in accordance with *Final Work Plan for Landfill Monitoring Program,* as amended (ITSI, 1999 and ITSI, 2000). Perform monthly monitoring of GMP-5 to GMP-13 and 15 additional probes to be installed in 2001 for a period of one year beginning April 2001 and quarterly thereafter.	**Monitoring Combined with Installation of Passive Cap-Venting System:** Provide for passive ventilation of landfill gas from beneath the RCRA cap.	**Monitoring Combined with Installation of Buffer-Zone Venting Trench:** Provide for passive ventilation of landfill gas within the buffer zone.	**Monitoring Combined with Installation of an Active Buffer-Zone Venting Trench:** Provide for active ventilation of a trench to treat landfill gas and/or methane-containing groundwater in the buffer zone adjacent to the lateral limits of the RCRA cap.	**Monitoring Combined with Installation of Utility Protection System:** Retrofit existing utilities, and install protections: backfill plugs/dams, relief/aeration vents, and conduit seals or vents in subsurface utilities within the buffer zone.	**Monitoring Combined with Activation of the Existing Groundwater Pump-and-Treat System:** Reactivate the groundwater treatment system.	**Monitoring Combined with an Active Extraction System with Pre-established System Shutdown Criteria:** Install and operate an active landfill gas collection system until a specific criterion is met.
Criteria							
Risk	• Monitors for methane in buffer zone • Does not reduce risk of migration • Monitors receptor protection	• Lateral gas migration could still occur	• Mitigates risk of methane migration	• Mitigates risk of methane migration	• Does not reduce risk of methane migration • Provides receptor protection where installed	• Not likely to reduce risk of methane migration	• Reduces risk of gas migration while system operates • Long-term lateral gas migration could still occur
Feasibility	• Feasible	• May not be feasible • Penetrations of RCRA cap not likely to receive regulatory approval • Significant lead time for design, approval, permitting, and construction	• Highly feasible • Additional data needed for optimal placement and design	• Feasible • Additional data may be needed for optimal design	• Feasible • Requires coordination with developer • May present construction difficulties for retrofits • Does not guarantee protection of future utilities	• May not be feasible • Significant lead time and rehabilitation effort required to reactivate system	• May not be feasible • Penetrations of RCRA cap not likely to receive regulatory approval • Significant lead time for design, approval, permitting, and construction
Expected Efficiency	• Not efficient in remediating methane • Efficient monitoring of presence and movement of methane in buffer zone1 • Efficient monitoring of receptors	• Will not remediate methane in the buffer zone • Should reduce gas pressure within landfill • Efficient monitoring of presence and movement of methane in buffer zone • Efficient monitoring of receptors	• Efficient at intercepting methane from landfill • May not be efficient at spreading oxygen outside of the trench, unless temporary active blowers used • Efficient monitoring of presence and movement of methane in buffer zone • Efficient monitoring of receptors	• Efficient at reducing risk of methane migrating through buffer zone • Relatively efficient at oxygenating soil on both sides of the trench • Efficient monitoring of presence and movement of methane in buffer zone • Efficient monitoring of receptors	• Not efficient in remediating methane in the buffer zone • Efficient in mitigating methane in utility trenches within the buffer zone	• Existing plant not designed to treat dissolved methane • Not efficient in remediating methane in the buffer zone	• Not efficient in remediating methane in the buffer zone • Likely to reduce gas pressure in the landfill delivery period of operation
Estimated Cost	• 30-year annualized cost $110,000 per year • Net present value $1.2 million total cost	• Total 30-year annualized cost $140,000 per year ($110,000 of which is the Option 1, monitoring, component) • 30-year annualized cost $30,000 per year for the Option 2 specific components • Net present value $1.6 million total cost ($1.2 million of which is the Option 1, monitoring, component)	• Total 30-year annualized cost $130,000 per year ($110,000 of which is the Option 1, monitoring, component) • 30-year annualized cost $20,000 per year for the Option 3 specific components • Net present value $1.4 million total cost ($1.2 million of which is the Option 1, monitoring, component)	• Total 30-year annualized cost $140,000 per year ($110,000 of which is the Option 1, monitoring, component) • 30-year annualized cost $30,000 per year for the Option 4 specific components • Net present value $1.6 million total cost ($1.2 million of which is the Option 1, monitoring, component)	• Total 30-year annualized cost $120,000 per year ($110,000 of which is the Option 1, monitoring, component) • 30-year annualized cost $10,000 per year for the Option 5 specific components • Net present value $1.3 million total cost ($1.2 million of which is the Option 1, monitoring, component)	• Total 30-year annualized cost $280,000 per year ($110,000 of which is the Option 1, monitoring, component) • 30-year annualized cost $170,000 per year for the Option 6 specific components • Net present value $3.1 million total cost ($1.2 million of which is the Option 1, monitoring, component)	• Total 30-year annualized cost $200,000 per year ($110,000 of which is the Option 1, monitoring, component) • 30-year annualized cost $90,000 per year for the Option 7 specific components • Net present value $2.2 million total cost ($1.2 million of which is the Option 1, monitoring, component)

dissolved methane needs to be treated. Operation and maintenance costs associated with this option are expected to be significant. There is also the potential for vandalism of visible and accessible components of the system.

Option 5 (Monitoring Combined with Installation of Utility Protection System) was evaluated to be a comparatively low priced option and feasible to implement. This option is not intended to be effective in remediating soil gas methane or dissolved methane in groundwater within the buffer zone or the landfill. This option would provide monitoring of soil gas concentrations around the south-southeast perimeter of the buffer zone and would protect receptors from methane potentially migrating in utility trenches.

Option 6 (Monitoring Combined with Activation of the Existing Groundwater Pump and Treat System) was evaluated to be the highest priced option and most difficult to implement. This option was expected to be potentially effective in remediating soil gas methane in the buffer zone of the landfill. There is uncertainty regarding the effectiveness of this option in remediating methane at the landfill. Additional studies would be required to anticipate the complex relationships within and beyond the landfill prior to considering this option. The startup, operation, maintenance, and monitoring costs of this option are expected to be significant.

Option 7 (Monitoring Combined with an Active Extraction System with Pre-Established System Shutdown Criteria) was evaluated to be a comparatively high priced option and potentially difficult to implement due to penetrations of the RCRA cap and significant lead time for design, approval, permitting and construction. This option was not expected to be effective in remediating soil gas methane or dissolved methane in groundwater within the buffer zone of the landfill.